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DRAWINGS ATTACHED

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(54) AN IMPROVEMENT IN OR RELATING TO MULTI-CYLINDER INTERNAL COMBUSTION ENGINES

(71) I, JAMES WOOD SENIOR, a British Subject of Moorwoods Hall Farm, Moorwoods Lane, Owler Bar, Sheffield, S17 3BS, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed to be particularly described in and by the following statement:—

The invention relates to multi-cylinder internal combustion engines and has for its object to provide an improvement therein. In particular, it is the object of the invention to provide a multi-cylinder internal combustion reciprocating piston engine of improved efficiency by reducing the work done by the pistons against the atmosphere at low throttle openings and especially whilst the engine is idling.

According to the invention, a multi-cylinder internal combustion reciprocating piston engine operating on the four-stroke cycle is provided with respective inlet and exhaust valves, mechanism for opening and closing said valves in the required sequence, and means for varying the valve timing in accordance with the pressure in an inlet manifold communicating with respective inlet ports, the arrangement being such that in response to a reduction of pressure in said manifold the closure of the respective inlet valves is delayed so that a fresh charge of fuel/air mixture which is inspired into each cylinder is allowed to be partially forced back into the inlet manifold, and the opening of the respective exhaust valves is advanced so that very soon after the reduced fuel/air mixture has been ignited the cylinder is opened to atmosphere. The means for varying the valve timing in accordance with the pressure in the inlet manifold will preferably include a bellows member communicating with said inlet manifold. Preferably, also, these means will be such that a reduced pressure in the inlet manifold causes the effective shapes of respective valve tappets, against which lobes of inlet and exhaust camshafts act, to be modified. For this purpose said means will preferably include pairs of cam followers straddling respective valve tappets and bearing against shoulders formed on opposite sides of said tappetts, said followers also having surfaces which coincide with upper surfaces of said tappets during normal operation of the engine but which are moved to positions in which in effect they modify the shapes of the valve tappets as a result of a reduced pressure acting in the inlet manifold. The bellows member will preferably be connected to said pairs of cam followers by a control rod movable under the control of said bellows member, a common crosshead carried by said control rod, and respective control links connected to said crosshead and to the respective pairs of cam followers. The cam followers may be constrained to move, at their ends which are pivotally connected to the control links, about the axes of respective inlet and exhaust camshafts.

In order that the invention may be fully understood and readily carried into effect, the same will now be described, by way of example only, with reference to the accompanying drawings, of which:—

Fig. 1 is a diagrammatic view through a multi-cylinder reciprocating piston internal combustion engine embodying the invention, and

Figs. 2 and 3 are valve timing diagrams which will presently be referred to.

Referring now to Fig. 1, the internal combustion engine there illustrated includes a cylinder block 10 in which a plurality of cylinders are formed one behind another (one cylinder 12 being shown in the drawing). The cylinders contain respective pistons, such as 14, connected to

a crank shaft (not shown) by means of respective connecting rods (not shown) in normal manner. A cylinder head 16 is bolted to the cylinder block and defines respective combustion chambers, such as 18, overlying the cylinders. Valve gear for the engine is mounted in the cylinder head and includes respective inlet valves, such as 20, and respective exhaust valves, such as 22. The heads of the valves can close respective inlet ports 24 and respective exhaust ports 26, as shown, but can open in sequence to allow the cylinders to inspire a fresh fuel/air mixture or to allow the exhaust of spent gases as the case may be. The valve stems are slidably mounted in respective liners, such as 28, and are surmounted by respective tappets, such as 30, which are acted upon by respective lobes of inlet and exhaust camshafts 32 and 34 to open the valves in the required sequence against the force of springs (not shown).

Means are provided for modifying the valve timing in accordance with the pressure in an inlet manifold (not shown) which communicates with the inlet ports. These means take the form of a bellows member 36 which communicates by means of a pipe 38 with the inlet manifold; a depending control rod 40 movable vertically under the control of said bellows member; a common crosshead 42 carried at the lower end of the rod 40 and pivotally connected to the lower ends of respective control links 44 and 46; and respective pairs of movable cam followers 48 and 50 pivotally connected to the upper ends of the control links at pivot points 52 and 54.

The pivot points 52 and 54 are constrained to move in respective arcs about the axes of the camshafts 32 and 34 by guide links 56 and 58 which are free to pivot about the axes of said camshafts and which are pivotally connected to the pairs of cam followers and to the control links at pivot points 52 and 54 respectively.

The pairs of movable came followers 48 and 50 straddle respective valve tappets and have curved portions 60 which bear against shoulders 62 formed on opposite sides of said tappets. The cam followers also have flat surfaces 64 which during normal operation of the engine coincide with the upper surfaces of the tappets, as shown in full lines, and in this position they do not affect the valve timing of the engine in any way. However, when the pressure in the inlet manifold (not shown) falls as a result of throttle closure, and during idling of the engine, the cam followers move to the positions shown in chain-dotted lines in the drawing. Consequently, it will be seen that this has the effect of modifying the effective shapes of the respective tappets against which the lobes of the camshafts act. The result is that the exhaust valves open sooner (although closing normally) and the inlet valves close later (although opening normally).

The variation in valve timing in accordance with inlet manifold pressure is shown diagrammatically in Figs. 2 and 3. Fig. 2 is a valve timing diagram which indicates the operating cycle of the engine at full throttle. The engine operates on the four-stroke cycle and it will be seen that during normal operation each inlet valve opens at *I.V.o* just before top dead centre position of the crank shaft "throw" concerned and closes at *I.V.c* just after bottom dead centre, and the exhaust valve opens during the following crankshaft revolution at *E.V.o* just before bottom dead centre and closes at *E.V.c* just after top dead centre. Fig. 3 is the valve timing diagram when the engine is idling however, that is to say when the valve timing has been varied as a result of manifold depression. It will be seen that inlet valve opening at *I.V.o.* and exhaust valve closure at *E.V.c* remain unchanged but that inlet valve closure at *I.V.c* has been delayed to a point approaching the top dead centre position (with the result that a fresh charge of fuel/air mixture which has been inspired is allowed to be partially forced back into the inlet manifold) and exhaust valve opening at *E.V.o* has been advanced to a point closer to the top dead centre position (with the result that the cylinder is opened to atmosphere very soon after the reduced fuel/air mixture has been ignited and the piston concerned is consequently saved from doing work against the atmosphere. In other words, the reduced charge is not expanded to below atmospheric pressure).

It has been found that by varying the valve timing in this manner in accordance with inlet manifold pressure there is obtained an improved efficiency, that is to say a significant saving of fuel when idling, and a substantial reduction in the volume of exhaust gases discharged. The reduced fuel/air mixture is sufficient to keep the engine idling. Greater power is developed when an increased charge is allowed to be inspired and the engine operates normally at full throttle.

WHAT I CLAIM IS:—

1. A multi-cylinder internal combustion reciprocating piston engine operable on the four-stroke cycle provided with respective inlet and exhaust valves, mechanism for opening and closing said valves in the required sequence, and means for varying the valve timing in accordance with the pressure in an inlet manifold communicating with respective inlet ports, the arrangement

being such that in response to a reduction of pressure in said manifold the closure of the respective inlet valves is delayed so that a fresh charge of fuel/air mixture which is inspired into each cylinder is allowed to be partially forced back into the inlet manifold, and the opening of the respective exhaust valves is advanced so that very soon after the reduced fuel/air mixture has been ignited the cylinder is opened to atmosphere.

2. An engine according to claim 1, in which the means for varying the valve timing in accordance with the pressure in the inlet manifold includes a bellows member communicating with said inlet manifold.

3. An engine according to either one of the preceding claims (in which the means for varying the valve timing in accordance with the pressure in the inlet manifold are such that a reduced pressure in the inlet manifold causes the effective shapes of respective valve tappets, against which lobes of inlet and exhaust camshafts act, to be modified.

4. An engine according to claim 3, in which said means include pairs of cam followers straddling respective valve tappets and bearing against shoulders formed on opposite sides of said tappets, said followers also having surfaces which coincide with upper surfaces of said tappets during normal operation of the engine but which are moved to positions in which, in effect, they modify the shapes of the valve tappets as a result of the reduced pressure acting in the inlet manifold.

5. An engine according to claim 4, when dependent on claim 2, in which the bellows member is connected to said pairs of cam followers by a control rod movable under the control of said bellows member, a common crosshead carried by said control rod, and respective control links connected to said cross head and to the respective pairs of cam followers.

6. An engine according to claim 5, in which the cam followers are constrained to move, at their ends which are pivotally connected to the control links, about the axes of respective inlet and exhaust camshafts.

7. A multi-cylinder internal combustion reciprocating piston engine constructed, arranged and adapted to operate substantially as hereinbefore described with reference to and as illustrated by the accompanying drawings.

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2 SHEETS

COMPLETE SPECIFICATION

SHEET 1

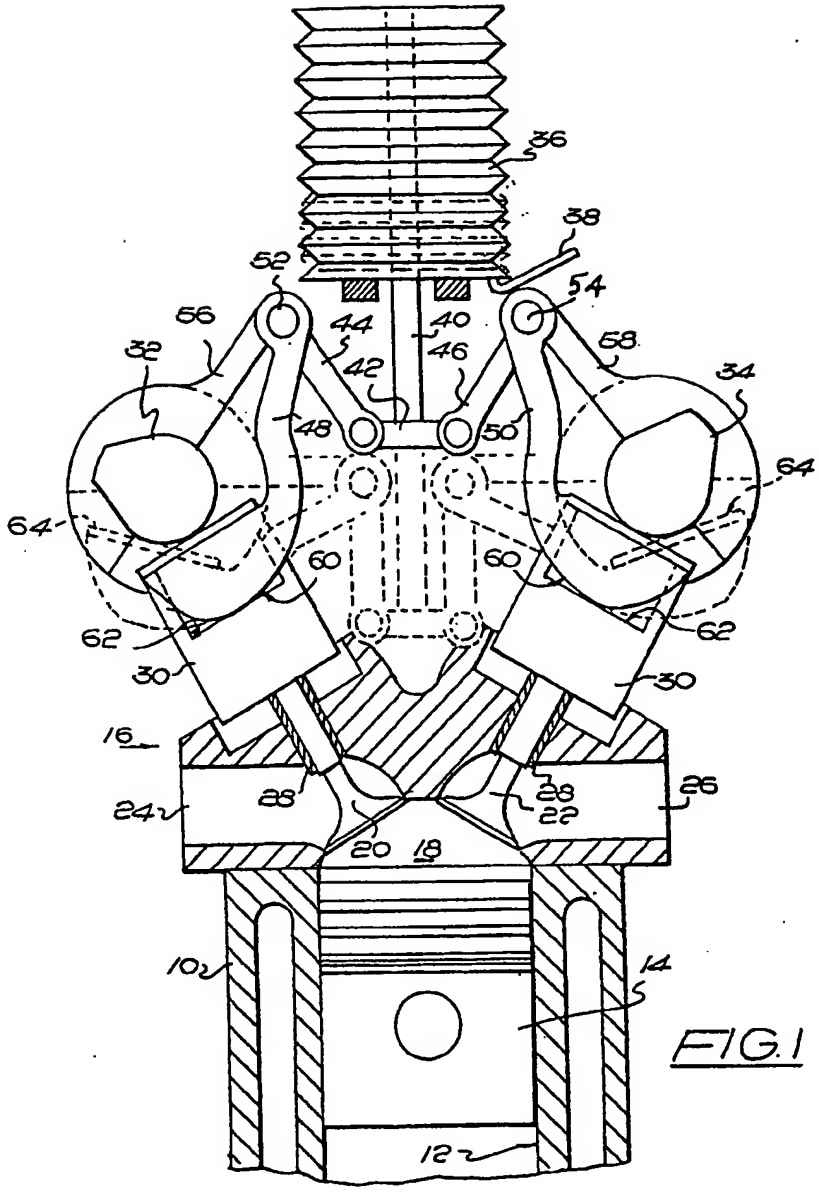

FIG.1

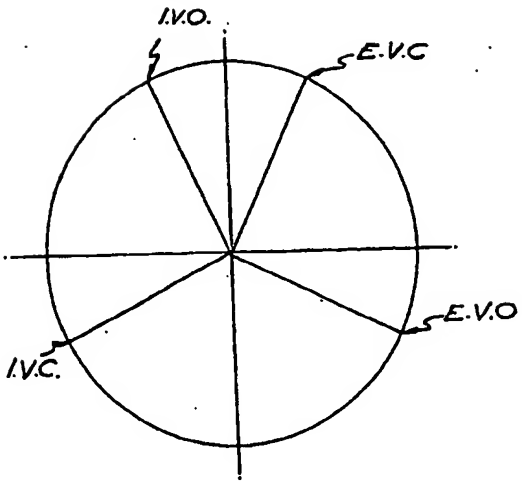

FIG. 2

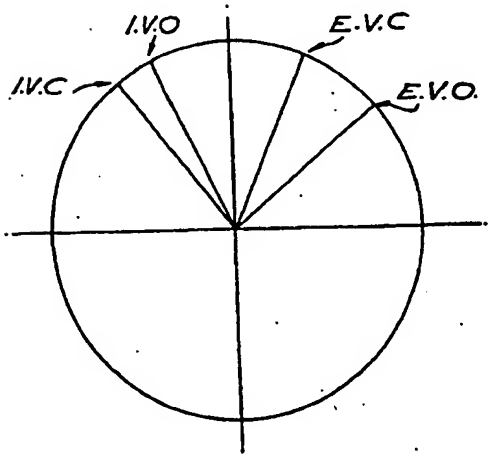

FIG. 3